

all—he made anthropological observations, and collected ethnographical objects. These are now in the Ethnographical Museum in Florence, and illustrations of a considerable number of them are found in his work. Besides these tribes, the book also deals with the Bashkirs and Kirghises, whom the author visited in returning to Europe.

THE last *Bulletin* (No. 6) of the Geographical Society of Belgium contains a paper by M. Oscar Royer describing his journey on the Congo; notes on a journey in Texas, by Mr. Lancaster; also "Some words on Atlantis," by M. de Bloek, who regards this fabulous region as merely one of those invented by the ancients for the purpose of working out in imagination their social and political theories. Finally, a study on the first narrative of Columbus, and the old printed editions of it, with a fac-simile of the first "Epistola C. Coloni," printed at Antwerp in 1493.

THE INSTITUTION OF MECHANICAL ENGINEERS

THIS Institution held its annual general meeting in London last week. The list of papers to be read we have already given, though some of them were not read; the only one calling for special notice at our hands is that of Sir Frederick Abel on a "Final Report bearing upon the Question of the Condition in which Carbon exists in Steel." The following are the conclusions which Sir Frederick bases on the present and on the two preceding reports:—

"The results of the experimental work described appear to warrant the following conclusions in regard to characteristics, recognisable by chemical examination, which are exhibited by different portions of one and the same sample of steel presenting marked physical differences consequent upon their exposure to the hardening, annealing, or tempering processes.

(1) In annealed steel the carbon exists entirely, or nearly so, in the form of a carbide of iron, of uniform composition (Fe_3C or a multiple thereof), uniformly diffused through the mass of metallic iron.

"(2) The cold-rolled samples of steel examined were closely similar in this respect to the annealed steel, doubtless because of their having been annealed between the rollings.

"(3) In hardened steel the sudden lowering of the temperature from a high red heat appears to have the effect of preventing or arresting the separation of the carbon, as a definite carbide, from the mass of the iron in which it exists in combination; its condition in the metal being, at any rate mainly, the same as when the steel is in a fused state. The presence of a small and variable proportion of Fe_3C in hardened steel is probably due to the unavoidable and variable extent of imperfection, or want of suddenness, of the hardening operation; so that, in some slight and variable degree, the change due to annealing takes place prior to the fixing of the carbon by the hardening process.

"(4) In tempered steel the condition of the carbon is intermediate between that of hardened and of annealed steel. The maintenance of hardened steel in a moderately heated state causes a gradual separation (within the mass) of the carbide molecules, the extent of which is regulated by the degree of heating, so that the metal gradually approaches in character to the annealed condition; but, even in the best result obtained with blue-tempered steel, that approach, as indicated by the proportion of separated carbide, is not more than about half-way towards the condition of annealed steel.

"(5) The carbide separated by chemical treatment from blue- and straw-tempered steel has the same composition as that obtained from annealed steel.

"It does not appear that this inquiry can be further extended with the prospect of obtaining any additional facts—elucidating the condition of the carbon in steel exhibiting various physical characteristics—the value of which would bear any proportion to the very laborious nature of the necessary experimental work, which has to be conducted with small quantities of material on account of the necessity of carrying out the annealing, hardening, and tempering processes with very thin pieces of steel.

"I believe it will be admitted that, although the data obtained have not led to the discovery of a ready chemical method of differentiating between different degrees of temper in steel (a method of examination which Prof. Hughes's interesting results have almost rendered unnecessary), they have at any rate contributed to the advancement of our knowledge of the nature of steel."

THE INFLUENCE OF DIRECT SUNLIGHT ON VEGETATION

THE influence of direct sunlight on vegetation is generally known, but surely deserves to be a subject of special study. In the following paper we shall only endeavour to describe some facts with relation to this influence. In the first place, the effect of the sun's rays in the tropical regions will be traced, and afterwards in the temperate and arctic zones. The constant high temperature within the tropics is the cause of the plants being less dependent on the direct solar heat than is the case in the greater part of the temperate and cold zones, but, notwithstanding this, there are plants even in the tropical regions requiring for a luxuriant growth the direct rays of the sun.

Of the tropical monocotyledonous plants, the palms are doubtless the most important, and of these the date-palm of the Sahara Desert (*Phoenix dactylifera*, L.) furnishes daily food to the inhabitants of this part of Africa.

It is known that the subterranean wells are the only cause of vegetation in this desert. When a well is discovered, in a short time an oasis arises, and the date-palm appears.

Considering that the first condition for the growth of palms is a humid soil wherein the roots may vegetate, there seems to be at first something strange in the fact of the Great Desert producing species of this family; but the Arabs say that this "Queen of the Oasis" puts her feet in water and her head in the fire of heaven; and this is the cause of the rapid growth of the plant (Greisbach, "Die Vegetation der Erde," Theil ii. p. 87); the water ascends by the roots into the tissue of the tree, and communicates its temperature to the inner parts, so that the influence of the sun's heat is tempered; the evaporation of the plant also causes a lower temperature; thus it withstands a difference of 98° (from 126° to 28°), as occurs in the Desert (Martins, "Le Sahara," *Revue des deux Mondes*, 1864, vol. lii. p. 613).

Though, as we have said above, these plants require, in the first place, water for their roots, the fact of the stems growing in their wild state at a considerable distance the one from the other, and never forming dense forests, proves that they require also the light.

But the date-palm is indigenous to the Great Desert; nowhere else does this plant vegetate so rapidly. When cultivated with success, it is also in a desert-climate, as, for instance, in that of Murcia in Spain (the date forest of Elche), the highlands of Afghanistan, &c. The cause of its culture being without fruits in the Mediterranean is the dry summer, there being no subterranean wells, as is the case in the Sahara.

The sugar-cane (*Saccharum officinarum*, L.) is also a plant requiring the direct solar light; moist climates are disadvantageous to its cultivation. Thus the climate of China, with its heavy rains in May and June (Dove, "Klimatologische Beiträge," vol. i. p. 102), but less precipitation in autumn, when the fruits ripen, is suited for the culture of this plant. It is known that the quantity of sugar depends on the quantity of sunshine.

Turning to the warm temperate zone we see the species of *citrus* cultivated in the sunny climate of Southern Italy, and even by cultivation produce the delicious fruits generally known, because they are in summer under the almost constant influence of the sun's rays in open localities. In the Malayan Peninsula, the supposed native country of these plants, they also grow in open spaces and not in the jungles, requiring a moist soil, but also the solar light, to ripen their fruits; this explains why the finest and largest oranges are obtained when the trees are trained against walls, as is the case in some parts of Southern England.

The vine (*Vitis vinifera*, L.) is also a plant requiring heat in the after summer to ripen its fruits; the climate of Southern France and Italy is therefore well adapted for its cultivation. In the continental climate of Bokhara in Turkestan (40° N. lat.), with its hot summers (in the sandy desert on the Oxus River the soil was found to have a temperature of 144° —Basiner, "Reise durch die Kirgisenteppe nach Chiwa"), the plant is cultivated in the open fields; its winter covering is not taken off before the end of March, but in April the temperature is already very high, and in July it becomes insupportable; the fruit of the vine is ripe by the end of June or the beginning of July. The soil is moistened here by artificial irrigation. A

¹ Mean temperature at Samarkand, lat. $39^\circ 39'$, in 1881: April 61° , May 70° , June 77° , July 81° , August 77° , September 68° , and December 28° ; mean temperature at 1 p.m. in June 86° , in July 93° , in August 92° , in September 81° .

climate with sudden changes of temperature, as, for instance, in the United States, does not suit this plant. On the banks of the Ohio River the fruits are rotten, or fall down, before they are ripe, notwithstanding that the mean temperature of all the months at Cincinnati is higher than at Pesth in Austria; but the American species are cultivated with success.

In California, with its equal temperature, the vine is cultivated, though the mean temperature at San Francisco is much lower than in Europe in the same latitude; but the dry Californian summer is not to be found throughout the United States, where heavy rains occur at this season.

Everywhere, in the warm as well as in the temperate regions, corn is cultivated with success where there is in summer direct sunlight enough to ripen its grains: on the highlands of Afghanistan, in China, on the plains of Southern Russia, on the highlands of Mexico, &c.—for these plants require also the direct solar warmth.

On highlands the influence of insolation is very much increased. At Leh, in Tibet, altitude about 12,000 feet, the thermometer rose in July, in the sun, to 144°, and in mid-winter to 84°, though the mean summer temperature is only 61°, and that of the winter 16°. Barley is sown about May 18 and harvested on September 12; but in the valley of Pituk (altitude about 11,000 feet) barley was sown and harvested in two months.

But, in the first place, the solar warmth of the after summer is necessary to ripen the fruits of the most important plants; for the vine a September temperature of at least 59° is thought to be necessary (Greisbach, "Die Vegetation der Erde," theil i. p. 126). Now, if we compare the means of this month of certain places in Southern England (Greenwich 57°, Penzance 57°, Chiswick 57°, Isle of Wight 58°) with others on the Continent (Liege 61°, Mannheim 62°), we see it is clear that the cloudy sky and rain, and not the mean temperature, are the causes of the vine being cultivated without success in England.

The limit of corn cultivation ascends on the Continent generally farther to the north than on the shores—Fort Norman (N.W. Territories of Canada) 65°, Yakutsk 62°.

The fact of its reaching 70° N. lat. in Norway (Alten), and the impossibility of agriculture in Greenland, even under 60°, and in Iceland (Reikiavik), notwithstanding the mean summer temperature of Alten and Reikiavik being about equal,² can only be explained by the continual clear sky in summer at Alten, and by the powerful insolation here, which is not the case in Iceland. The continual wet climate and absence of sunlight make the grains rot on the stalks before they are ripe (Martins, "Essai sur la Végétation de l'Archipel des Féroé," pp. 388, 392). The period of vegetation at Alten is the same as that in Siberia (Yakutsk), though the mean summer temperature is 9° lower.

But a climate such as that of Northern Norway, where the shores are free of ice even in mid-winter, caused by the north-east branch of the Gulf Stream, is nowhere to be found on the globe under such a high latitude. On the north-east shores of Asia corn cannot be cultivated even under 50° N. lat. The same latitude is its limit on the eastern shores of America; on the western it reaches about 57°. On the north-east shores of Asia the cause is the ice in the sea of Ochotsk, the wind in summer being mostly south-east or south,³ thus coming from the sea or along the shores, and causing much lower summer temperatures than in the interior,⁴ and cloudy sky. On the north-east shores of North America the corn limit reaches 50° N. lat., the cause being here the ice in Hudson Bay and along the shores of Labrador and Newfoundland.⁵ But again, it is not alone the low mean temperature which causes the corn limit to descend so far southerly, but want of sunlight.⁶

¹ Frost is observed in September, and lasts till the end of May. See Moorcroft, "Travels in the Himalayan Provinces."

² Summer temperature at Alten 53°, at Reikiavik 54°. See Dove, "Temperaturtafel."

³ On account of the barometric summer minimum over the Asiatic continent.

⁴ Temperature of Ochotsk, lat. 59° 21': June 46°, July 55°, August 50°, September 47°. Temperature of Nicolajefsk, lat. 53° 8': June 54°, July 61°, August 61°, September 50°. See Schrenck, "Reise im Amur Lande," bd. iv. p. 405.

⁵ Mean temperature in 1876 at York Factory, lat. 57°: June 49°, July 55°, August 53°. Mean temperature in 1880 at Moose Fort, Ontario, lat. 51° 10': June 55°, July 59°, August 55°, September 52°. See Report of the Meteorological Service in Canada.

⁶ Percentage of sky clouded, Nikolajefsk of the Amur: June 53, July 59, August 63. See Schrenck, "Reise im Amur Lande," bd. iv. p. 476. Percentage of sky clouded in 1880 at Moose Fort: June 66, July 62, August 62. Number of rainy days: June 15, July 15, August 20. See Report of the Meteorological Service in Canada.

In the vicinity of the arctic zone the influence of insolation is, in the first place, observed on the Continent. At Turuchansk, lat. 65° 55', gourds are cultivated, though of a small size (Middendorff, "Sibirische Reise," band iv. theil i. p. 701). The mean temperature in 1881 was: Of June 48°, of July 59°, and of August 55°, the two last months being about equal in temperature to the means of Valentia in Ireland, lat. 51° 55' (July 59°, August 59°); but at Turuchansk there were, in June, 7 days with the temperature, at 1 p.m., ranging between 68° and 73°; in July, 15 days ranging between 68° and 82°; and in August, 16 days ranging between 62° and 75°. Number of days completely clouded: June 6; July 9; August 3. Snow did occur till June 15, and was observed again on August 29 (Annalen der Physikalischen Central Observatoriums, St. Petersburg). In Norway the cultivation of gourds (*Cucurbita Pepo*, L.) reaches 59° 55'.

In North America, at Cumberland House, lat. 53° 57', a sugar harvest is collected from *Negundo fraxinifolium*, Nutt. (*Acer negundo*, L.), by means of cuttings in the trees, but the flow of the sap is greatly influenced by the action of the sun's rays, and is greatest after a smart night's frost (Richardson, "Search Expedition through Ruperts Land," vol. ii. p. 236).

In summer, the influence of the direct sunlight causes the tropical mid-day temperature so common in the interior of both continents in the temperate zone; but in America the days' differences are much greater than in Asia;¹ even near the eastern shores (Montreal, Quebec, &c.) daily differences of 20° are of common occurrence in midsummer.

The Asiatic continent, reaching to the Arctic Sea, without interruption presents to the sun's rays a much greater surface than is the case with America, where the melting ice in Hudson's Bay and the Arctic Archipelago consumes the greatest part of the solar warmth, being at the same time the cause of the sudden low temperatures occurring when the wind turns to the north or north-west.

Notwithstanding this, the European vegetables and corn are cultivated with success in the United States and the interior of Canada, but some of them cannot stand the sudden changes of temperature, as, for instance, the vine, and also the orange-tree (*Citrus aurantium*, L., et var.); the general cultivation of the latter does not reach beyond 30° N. lat. (Florida).

Nowhere else is the influence of insolation more distinctly observed than in the arctic regions. It is known that in high latitudes the heat of the sun's rays in summer is often very great. Richardson remarks that (being under about 60° N. lat. near the Slave River) he had never felt the heat within the tropics so oppressive as he experienced it on some occasions in these arctic regions (Richardson, "Search Expedition," vol. i. p. 144), though the sun's rays are here always horizontal instead of vertical, as is the case in the tropical countries. The enormous multitude of mosquitoes suddenly appearing in spring when the ice is thawing, and in places where there is water for their larvæ (swamps, pools, &c.), is also much greater than in India.

The observations on the following page may give some idea of the difference between the temperature in the shade and that in the sun's rays.

At Fort Franklin, Great Bear Lake, North America, lat. 65° 12', the mean temperature in the last part of March or the beginning of April is about 0° F.; the effect of the sun's rays on the blackened bulb of a thermometer, however, is sufficient to raise the mercury to 90° (Richardson, "Search Expedition," vol. ii. p. 254).

Comparing these observations with those within the tropics we see that the difference between the maximum temperature in the sun in these regions and the northern is relatively small. Maximum temperature in the sun, 1882: Calcutta, 162°; Bombay, 151°; Colombo (Ceylon), 157°; Barbados, 156°. But in dry climates the difference is greater: Melbourne, 169°; Adelaide, 180°. The mean humidity at Adelaide was only 58 per cent.; highest temperature in shade 112°.

Even in the North American Arctic Archipelago, in Smith Sound, lat. 78° 30', where the mean summer temperature is only 33° (June 30°, July 38°, August 31½°), Kane's observations with the black bulb thermometer gave the following results:—

¹ Greatest difference at Winnipeg, lat. 49° 55', on July 2, 1881, maximum 98°, minimum 45°; difference 53°. At Poplar Heights, Manitoba, lat. 50° 5', maximum on May 20, 86°, minimum 27°; thus difference 59°. At Blagoweschensk, Siberia, lat. 50° 15', on May 25, 1881, maximum 79°, minimum 48°; difference 31°. At Akmolinsk, lat. 51° 12', on May 25, maximum 68°, minimum 50°; difference 18°.

From May 16 till September 4 the temperature in the sun's rays was constantly above the freezing-point (with exception of May 22, when this was not the case); on June 15 it reached 48°, on the 26th 54°, on July 5, 70°, and on August 11, 66°.

Observations at Parulov sk, Russia, Lat. 59° 43' 1

Date, 1881	Temp. in shade	Temp. in the sun's rays	Difference	Humidity %
Feb. 8	...	...	68	75
" 18	...	...	67	74
" 21	...	...	76	82
" 24	...	...	79	76
" 25	...	...	79	71
" 28	...	...	82	73
March 14	...	...	86	73
" 16	...	...	84	66
" 22	...	...	89	65
May 25	...	...	60	39
June 8	...	...	58	40
" 29	...	...	60	33
July 2	...	...	58	30
Aug. 10	...	...	67	72
Sept. 8	...	...	58	57
" 18	...	...	62	66
Oct. 10	...	...	55	63
Nov. 4	...	...	54	78

It is clear that the influence of the sun's rays increases with higher latitude, because the sun in summer rests above the horizon.

Now we come to the main point, viz. the effect of the direct solar heat on vegetation in the northern regions.

In Novaya Zemlya the vegetation (consisting chiefly of herbaceous plants) is, in places exposed to the sun's rays (at the foot of mountains), like an arctic flower-garden, the surface of the soil not being covered with grass as is the case in the temperate regions. The flowers are here of a much greater size than the leaves. In this island, and even in Spitzbergen, the snow disappears in summer by the action of the sun from hills exposed to its light; but on Ben Nevis in Scotland, being a difference in latitude of more than 20°, the snow rests sometimes the whole year.

In the Tundra of Siberia, on the declivities of hills sheltered from the winds and exposed vertically to the sun's rays, the same herbaceous vegetation, with its large, splendid-coloured flowers, is observed (Middendorff, "Sibirische Reise," bd. iv. th. i. p. 733), but this is not the case in plains where the sunlight in its horizontal direction cannot have so much influence on the vegetation of the frozen ground; therefore these plains are in general really deserts, only covered with moss.

Insolation is also the cause of the rich vegetation in some parts of the mountains in the temperate zone (Alps, &c.).

Even in the most northern regions there can be a rich vegetation where the plants in sheltered localities are exposed to the sun. Parry ("Attempt to reach the North Pole") found the scurvy grass (*Cochlearia*) on Walden Island under 80° 30' N. lat. in such a luxuriant growth as he had never seen it before.

Middendorff observed, under 74° 30' N. lat., on the borders of Lake Taimyr in Siberia, on August 2, a temperature of 52° in the shade; but a heliothermometer under glass placed in the sun's rays stood at 104°; an uncovered one marked, in the sun, 70°. The pitch on his boat was not only melted by this temperature, but flowed (Middendorff, "Sib. Reise," p. 657).

But, as is the case also in lower latitudes, the greatest difference between the temperature in the shade and in the sun occurs in early spring. In June, Middendorff was travelling in the Stanowoi Mountains, and saw a rhododendron in full flower; when he was about to gather some flowers of this plant he found not only the roots, but even the stem, frozen hard in the soil. The temperature of the air was between 54° and 43°, but at night it was some degrees below freezing-point.

The assertion of some botanists that the contents of the cells, as soon as they are frozen, make the latter burst, thus causing the death of the plants, has been already refuted by Nägeli; but the important observations of Middendorff have showed clearly that the severest frosts of the Asiatic cold pole, by which the innermost parts of the trees are frozen as hard as

iron, have little influence on the tissue when the cold becomes gradually more intense; only when the temperature sinks suddenly below the freezing-point of the mercury the wood splits with a thundering noise. These crevices have a disadvantageous influence on the vegetation of the tree in summer, because in these places the plant often begins to rot.

The trees rest in a frozen state till, in spring, the sun's rays reach the upper parts, and here vegetation is raised, though the roots and lower parts of the stem are still in a frozen state.

But the most interesting discovery on this subject was made by Middendorff under 69° 30' N. lat., on April 14, near the village of Dudino; notwithstanding the clear sky and incessant brilliant light of the sun, the temperature at mid-day ranged from -4° to -13°, yet before and after this time from -24° to -35°. While going over the glittering snow he was suddenly stopped by the sight of a willow-catkin peeping about an inch out of it. The catkin was wholly developed, yet the branch on which it was observed was, one or two inches down, solidly frozen; this was also the case with the other parts of the plant hidden under the snow (Middendorff, p. 653). Thus this little part of a branch was called to life, for some hours only, by the direct solar rays, in which it was thawed.

In the beginning of August, under lat. 74° 30', Middendorff found the soil exposed to the sun's rays heated to 86°, though the temperature about four inches below the surface was only 39°, and at the depth of about one foot the ground was constantly frozen (Middendorff, p. 666).

It is clear that plants in the high northern regions, when they vegetate, receive more warmth by insolation than is often supposed—1° by the direct solar light itself, and 2° by the heated surface of the ground. The snow and ice being melted by the sun, the necessary water and humid atmosphere never fail; even this is the cause of the luxuriant growth of grass on some places of the Tundra. The flowing water gradually communicates its warmth to the soil, and prevents also the nightly radiation.

All this is proof enough that, when the mean temperature in shade is known, this is not at all sufficient for a knowledge of the real temperature by which the vegetation of several plants is raised. What might have been the temperature in the tissue of the little branch and also in that of the willow-catkin, of which we have spoken? and this when the temperature in the shade was so many degrees below freezing-point.

In the temperate regions vegetation commences in spring, when the difference of temperature between night and day is greatest; in the high north this difference is often insignificant, because the sun rests above the horizon; but the temperature of the soil being at this time very much lower than that of the objects exposed to the sun's rays, even this great difference is the cause of the very rapid vegetation in sheltered localities and under the influence of the solar light.¹

In conclusion we must remark that the facts thus briefly mentioned show how much a new system of bio-meteorological observations is wanted to ascertain the real quantity of warmth and sunlight necessary for the growth of plants, many of which are of the utmost importance in the life of man.

M. BUYSMAN

NEW ORGANIC SPECTRA²

THE absorption-spectra to be described were detected by means of the microspectroscope, and most of them are only fully visible in it, as the dispersion of the chemical spectroscopic is too great for the detection of some of the very feeble bands. A binocular microscope provided with a substage achromatic condenser, to which are fitted two diaphragms, was specially made for this kind of work. Its objectives are so adapted as to enable both fields to be fully illuminated when any power up to the one-eighth is used. The left-hand tube is used as a "finder," and as a means of getting any required portion of the object into the centre of the field so that its spectrum may be obtained in the spectrum eyepiece of the right-hand tube. In this way the various portions of a very small bit of tissue or organ may be readily differentiated from each other and

¹ In 50° N. lat., on the banks of the Amur River, where the situation with regard to the ground-ice in spring is the same as in the Taimyr country, *Nasturtium* and *Colanagrotis* plants were observed to grow about half a foot every day (see *Beiträge zur Kenntniss des Russischen Reiches*, Band xxiii. pp. 547, 617).

² Abstract of a communication made to the Physiological Society, at the meeting on December 13, 1884 (and published in *Proceedings* No. iv. 1884), by Dr. C. A. MacMunn.

¹ *Annalen des Physikalischen Central Observatoriums*, St. Petersburg, 1881.